

# A dynamic Atmospheric Correction Scheme for NPOESS, VIIRS

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# A Purpose for Atmospheric Correction Surface Reflectance Retrieval!

Surface reflectance may be used to understand the,

- *effects of regional climate changes on agriculture*
- *ecosystem stress*
- *agricultural and water resources management*

... AS WELL AS ...

- *weather and climate research*
- *climate change and weather prediction model outputs, and*
- *soil moisture/boundary-layer interfacial parameterizations research.*

# ISSUES of Surface Reflectance Retrieval

Sensor Characteristics  
Solar and Viewing Geometries  
Atmospheric Constituents  
Land/Air Coupling Effects

# Atmospheric Correction METHODS

1. RT Model per pixel
2. Look Up Table (LUT)
3. **Hybrid** - LUT, RT Model

# HYBRID – VIIRS Design



Atmospheric Correction-Lambertian Assumption

Update A,B w/dynamic inputs →  $\rho_{ac}$   
*(All Pixels, EO Bands) – pass to Snow/Ice Module*

*Solve [(Coef<sub>a</sub>)  $\rho_{ac}^2$ ] + [(Coef<sub>b</sub>)  $\rho_{ac}$ ] = -(Coef<sub>c</sub>)  
assuming a **BRDF shape Model***

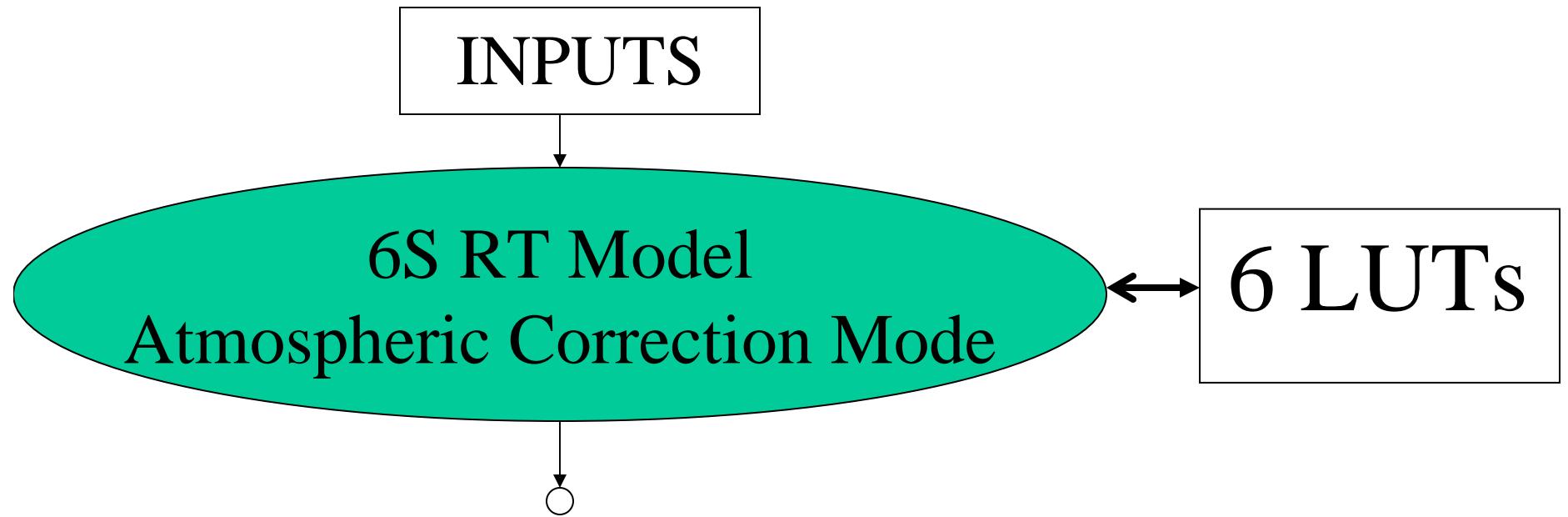
to yield  $\rho_{ac, BRDF}$  (All Pixels, EO Bands)

$$\rho_{ac,f} = \rho_{ac, BRDF} - [\langle \rho_{ac, BRDF} \rangle t_d] \text{ (per band, pixel)}$$

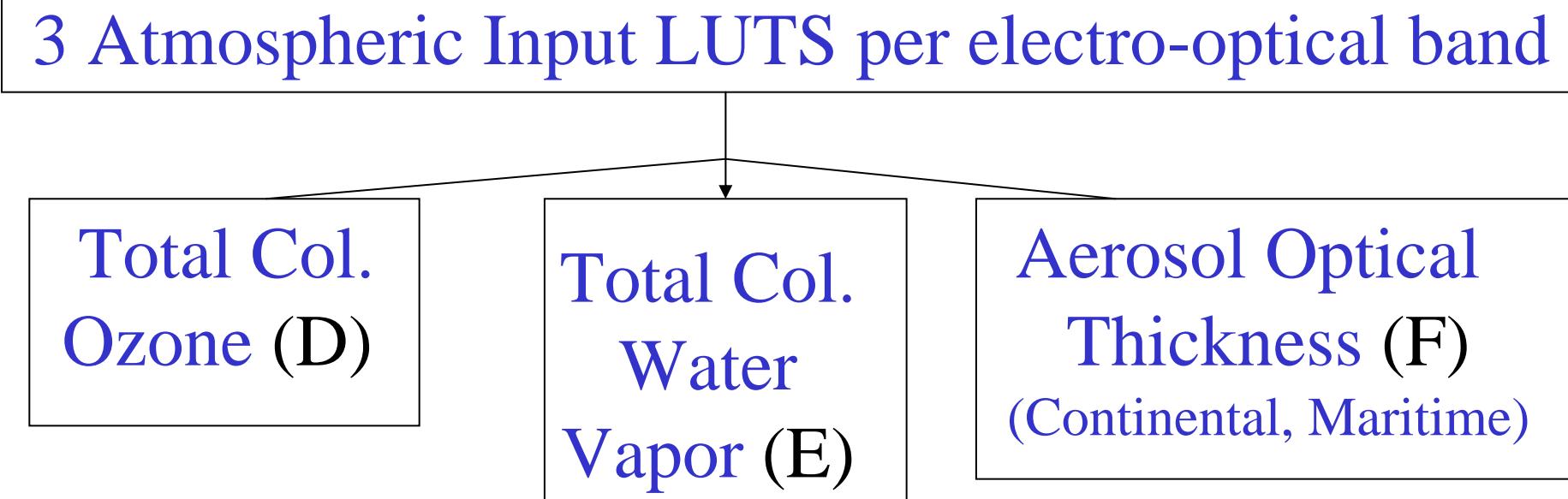
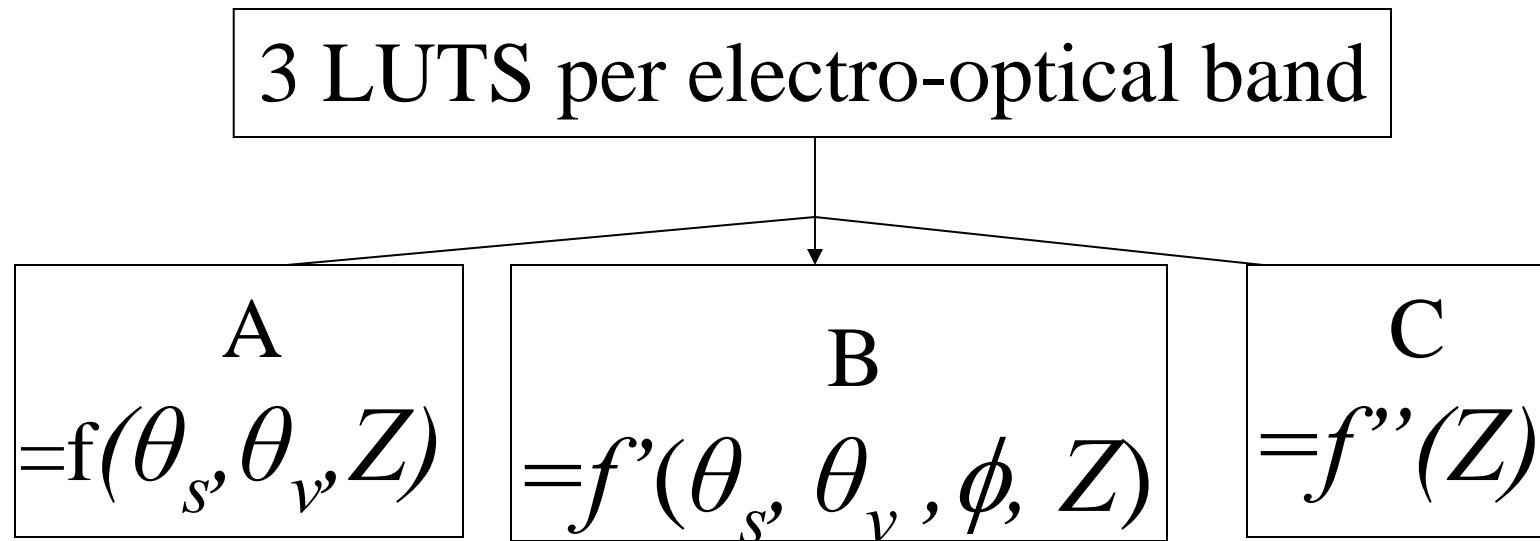


Pass  $\rho_{ac,f}$  to gridded IPs/EDRs, plus other Land Units

# HYBRID – (Lambertian Assumption Module)



# HYBRID—(Lambertian Assumption Module) (Cont.)



# HYBRID –(Lambertian Assumption Module) (Cont.)

Dynamic Atmospheric Inputs versus LUT A & B:

$$A = \pi / (\mu_s E_s T_s T_g)$$

$$B = -\rho_a / T_s$$

$T_s$  (*[scattering constituent(s)]*,  $\theta_s$ ,  $\theta_v$ , Z)

$T_g$  (*[gas constituent(s)]*,  $\theta_s$ ,  $\theta_v$ , Z)

$\mu_s$  = Cosine of solar zenith angle

$E_s$  = Spectral solar irradiance at top of atmosphere

$\rho_a$  = Intrinsic atmospheric reflectance

## HYBRID –(Lambertian Assumption Module) (Cont.)

Dynamic Atmospheric Inputs vs. LUTs D, E & F:

$$T_{aerosol} = (D)$$

$$T_{H2O} = (E)$$

$$T_{O3} = (F)$$

$$T_s = T_s \ T_{aerosol}$$

$$T_g = T_g \ T_{H2O} \ T_{O3}$$

$$A = A \ T_s \ T_g$$

$$B = B \ T_s$$

## HYBRID—(Lambertian Assumption Module) (Cont.)

$$\rho = (A R) + B$$

$$\rho_{ac} = \rho / [1 + (\rho C)]$$

Where,

R = radiometrically corrected radiance at satellite

C = Total Spherical Albedo of the sky LUT value for pixel

*A, B = Dynamically updated LUT value for pixel*

*$\rho_{ac}$  = Atmospherically corrected surface reflectance using  
Lambertian Assumption and coincident atmos. inputs*

# Hybrid-BRDF Correction Module

*Solve  $[(Coef_a) \rho_{ac}^2] + [(Coef_b) \rho_{ac}] = -(Coef_c)$*

*assuming a **BRDF shape Model***

to yield  $\rho_{ac, BRDF}$  (All Pixels, EO Bands)

- BRDF shape Model choice is an unresolved issue
  - Wrong choice can lead to worse errors than not including it.
- Heritage Sensor (MODIS) doesn't implement this correction

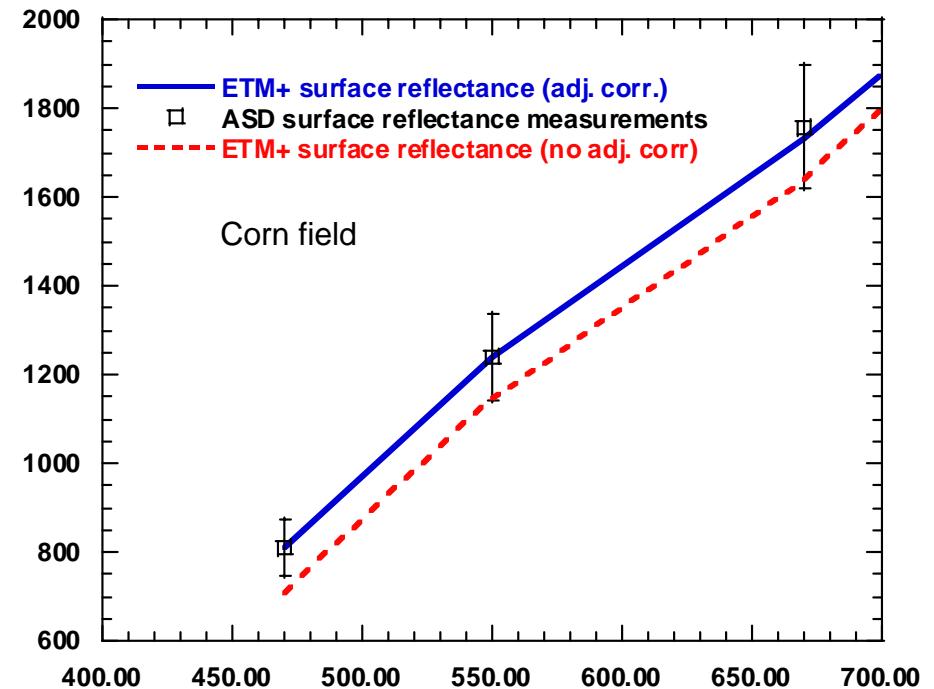
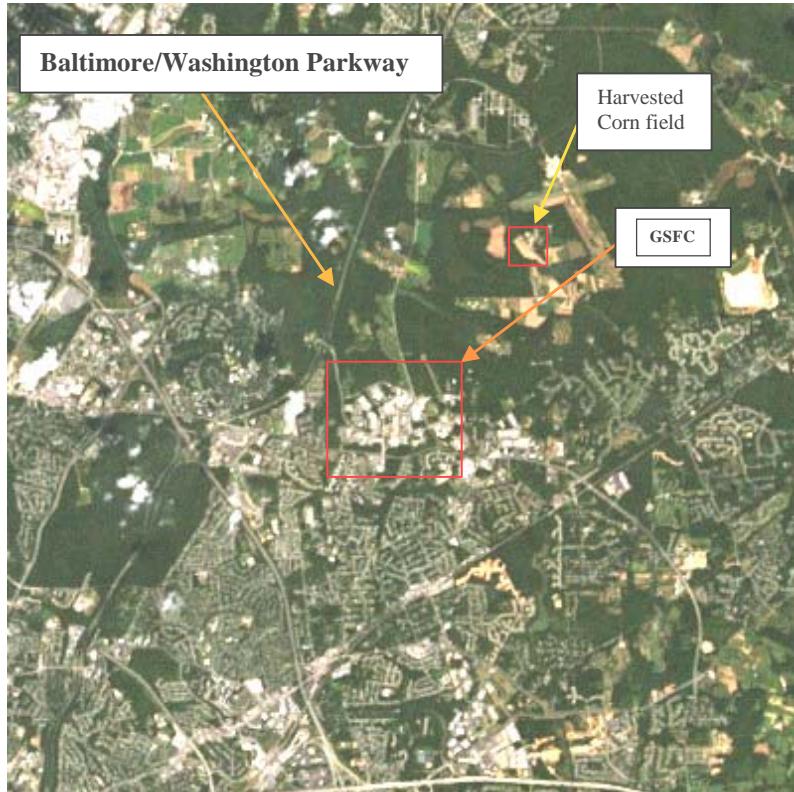
# Hybrid - Adjacency Correction Module

$$\rho_{ac,f} = \rho_{ac,BRDF} - [\langle \rho_{ac,BRDF} \rangle t_d] \text{ (per band, pixel)}$$

Generally Straightforward, but computationally intensive.

# pixels away from center pixel	(VIIRS_LandUnitTest_Image_Fall) ‘Real-time’ to process per center pixel
40	10 Hours
3	10 Minutes
1	10 Seconds

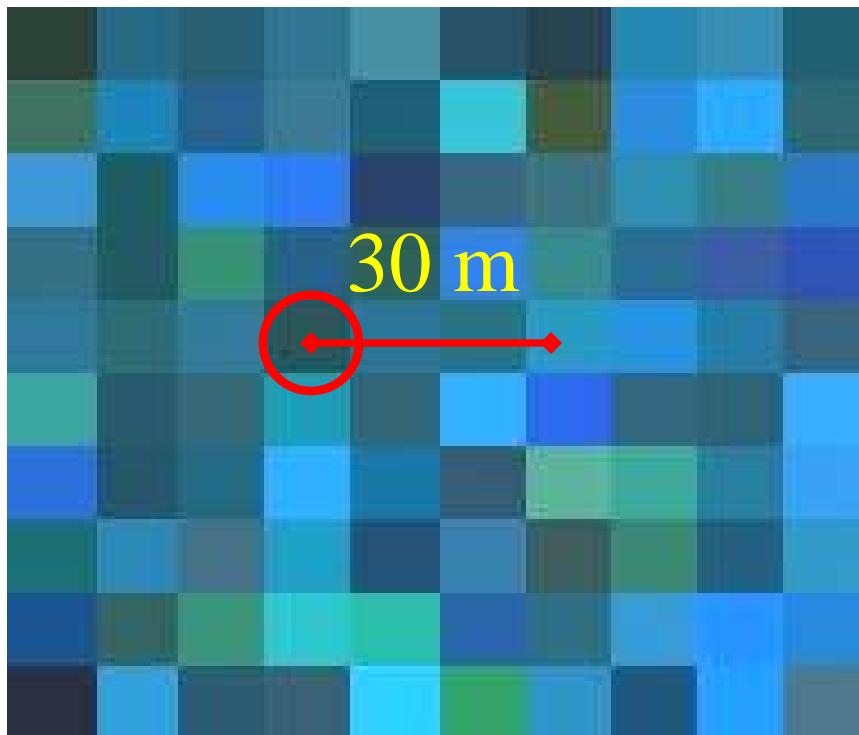
## Adjacency effect correction validation



# HYBRID APPROACH/DISCUSSION

## Process/Field Scale

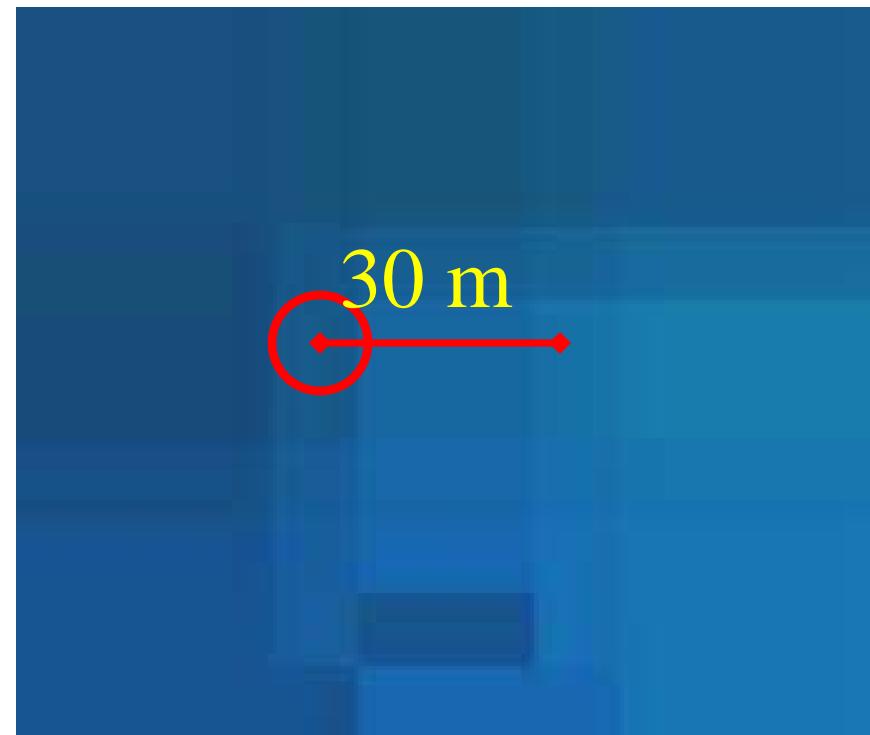
Crop Scan data from October 20, 2000  
EROS Data Center, TERESA Field Site



Percent Reflectance (10 m resolution)

{Range: 11 - 76 %  
Black, Dk Green - Br. Blue}

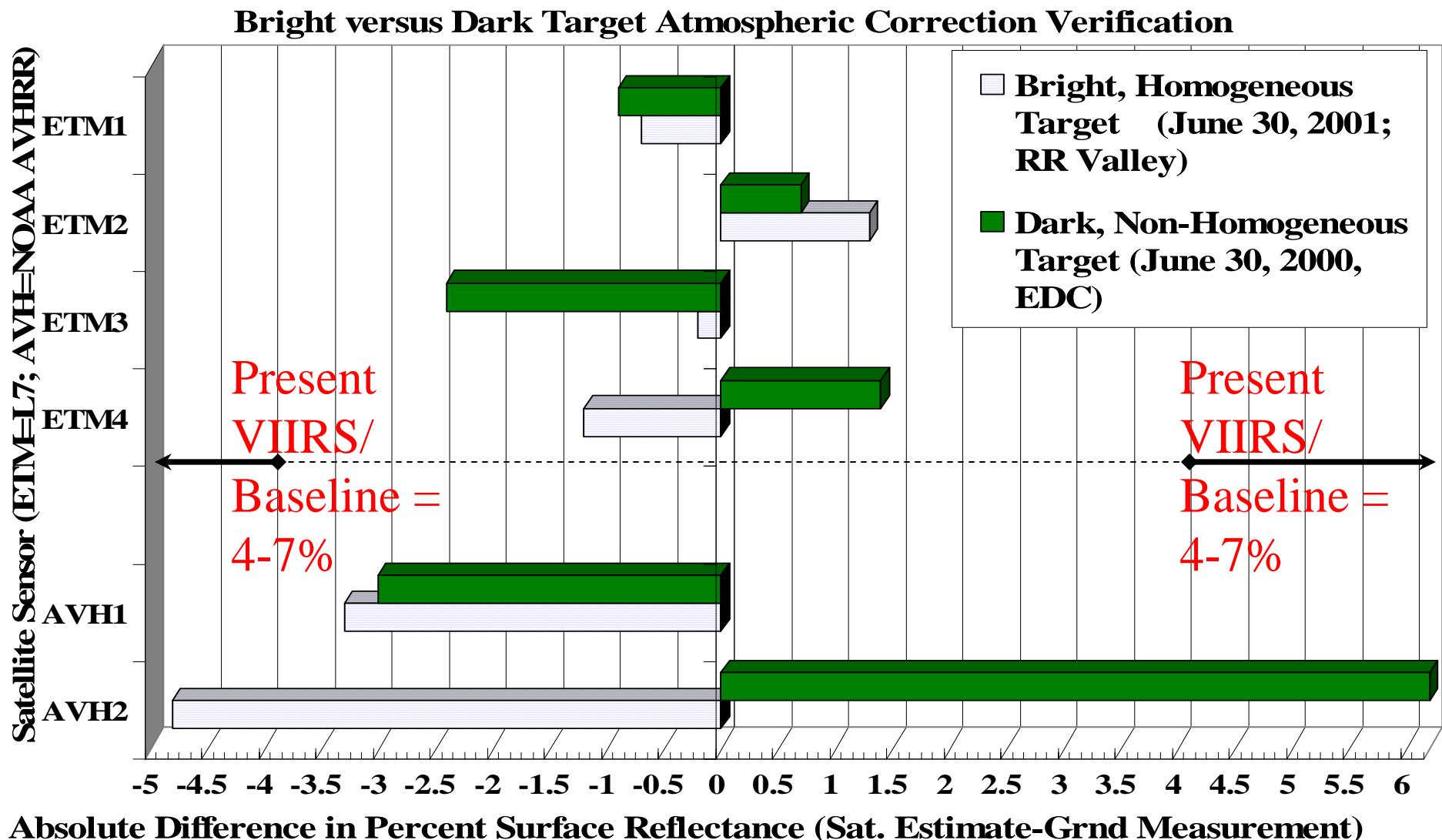
## Satellite (TM equiv) Scale



Percent Reflectance (30 m resolution)

{Range: 11 - 76 %  
Black, Dk Green - Br. Blue}

# Hybrid Approach w/o BRDF, Adjacency, Aerosol Corrections



# DISCUSSION (previous plot)

LANDSAT Scale

Bright Homog sfc vs Darker

**non-Homog sfc: ~0.1-0.5%**

**30 m resolution pixels**

No Aerosol Correction

No BRDF

No Adjacency

Lambertian Assumption

AVHRR Scale

Bright Homog sfc vs Darker

**non-Homog sfc: 0.3-1.5%**

**1,000 m resolution pixels**

No Aerosol Correction

No BRDF

No Adjacency

Lambertian Assumption

Overpass/Validation Data

Acquisition mismatch